**T08D11 – Acid Base Topic HL Exam**

**Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**1.** Four aqueous solutions, I, II, III and IV, are listed below.

I. 0.100 mol dm–3 HCl

II. 0.010 mol dm–3 HCl

III. 0.100 mol dm–3 NaOH

IV. 0.010 mol dm–3 NaOH

What is the correct order of **increasing** pH of these solutions?

A. I, II, III, IV

B. I, II, IV, III

C. II, I, III, IV

D. II, I, IV, III

**2.** Which methods will distinguish between equimolar solutions of a strong base and a strong acid?

I. Add magnesium to each solution and look for the formation of gas bubbles.

II. Add aqueous sodium hydroxide to each solution and measure the temperature change.

III. Use each solution in a circuit with a battery and lamp and see how bright the lamp glows.

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

**3.** Which **one** of the following species can act as both a Brønsted-Lowry acid and base in aqueous solution?

A. CH3COOH

B. NO3–

C. H2PO4–

D. OH–

**4.** An aqueous solution of which of the following reacts with magnesium metal?

A. Ammonia

B. Hydrogen chloride

C. Potassium hydroxide

D. Sodium hydrogencarbonate

**5.** Which is a conjugate acid-base pair in the following reaction?

HNO3 + H2SO4  H2NO3+ + HSO4–

A. HNO3 and H2SO4

B. HNO3 and H2NO3+

C. HNO3 and HSO4–

D. H2NO3+ and HSO4–

**6.** The equation for the reaction between nitric acid and sulfuric acid is shown below.

H2SO4 + HNO3  H2NO3+ + HSO4–

Which species are acting as acids in this reaction according to the Brønsted-Lowry theory?

A. H2SO4 and HNO3

B. H2SO4 and H2NO3+

C. HNO3 and H2NO3+

D. H2NO3+ and HSO4–

**7.** Which of the following is/are formed when a metal oxide reacts with a dilute acid?

I. A metal salt

II. Water

III. Hydrogen gas

A. I only

B. I and II only

C. II and III only

D. I, II and III

**8.** The pH of a solution is 2. If its pH is increased to 6, how many times greater is the [H+] of the original solution?

A. 3

B. 4

C. 1000

D. 10 000

**9.** Which equation represents an acid-base reaction according to the Lewis theory **but not** according to the Brønsted-Lowry theory?

A. CO32–(aq) + 2H+(aq) → H2O(l) + CO2(g)

B. Cu2+(aq) + 4NH3(aq) → CU(NH3)42+(aq)

C. BaO(s) + H2O(l) → Ba2+(aq) + 2OH–(aq)

D. NH3(g) + HCl(g) → NH4Cl(s)

**10.** Lime was added to a sample of soil and the pH changed from 4 to 6. What was the corresponding change in the hydrogen ion concentration?

A. increased by a factor of 2

B. increased by a factor of 100

C. decreased by a factor of 2

D. decreased by a factor of 100

**11.** Which substance can be dissolved in water to give a 0.1 mol dm–3 solution with a high pH and a high electrical conductivity?

A. HCl

B. NaCl

C. NH3

D. NaOH

**12.** In which reaction is H2PO4–(aq) acting as a Brønsted-Lowry base?

A. H2PO4–(aq) + NH3(aq) → HPO42–(aq) + NH4+(aq)

B. H2PO4–(aq) + OH–(aq) → HPO42–(aq) + H2O(l)

C. H2PO4–(aq) + C2H5NH2(aq) → HPO42–(aq) + C2H5NH3+(aq)

D. H2PO4–(aq) + CH3COOH(aq) → H3PO4(aq) + CH3COO–(aq)

**13.** The pH of solution **X** is 1 and that of **Y** is 2. Which statement is correct about the hydrogen ion concentrations in the two solutions?

A. [H+] in **X** is half that in **Y**.

B. [H+] in **X** is twice that in **Y**.

C. [H+] in **X** is one tenth of that in **Y**.

D. [H+] in **X** is ten times that in **Y**.

**14.** When the following 1.0 mol dm–3 solutions are listed in increasing order of pH (lowest first), what is the correct order?

A. HNO3 <H2 CO3 < NH3 < Ba(OH)2

B. NH3 < Ba (OH)2 < H2 CO3 < HNO3

C. Ba (OH)2 < H2 CO3 < NH3 < HNO3

D. HNO3 < H2 CO3 < Ba (OH)2 < NH3

**15.** Which substance, when dissolved in water, to give a 0.1 mol dm–3 solution, has the highest pH?

A. HCl

B. NaCl

C. NH3

D. NaOH

**16.** Lime is added to a lake to neutralize the effects of acid rain. The pH value of the lake water rises from 4 to 7. What is the change in concentration of H+ ions in the lake water?

A. An increase by a factor of 3

B. An increase by a factor of 1000

C. A decrease by a factor of 3

D. A decrease by a factor of 1000

**17.** Which change in [H+] causes the biggest increase in pH?

A. A change in [H+(aq)] from 1×10–3 to 1×10–2 mol dm–3

B. A change in [H+(aq)] from 1×10–3 to 1×10–4 mol dm–3

C. A change in [H+(aq)] from 1×10–4 to 1×10–2 mol dm–3

D. A change in [H+(aq)] from 1×10–4 to 1×10–6 mol dm–3

**18.** Which methods can distinguish between solutions of a strong monoprotic acid and a weak monoprotic acid of the same concentration?

I. Add magnesium to each solution and measure the rate of the formation of gas bubbles.

II. Add aqueous sodium hydroxide to each solution and measure the temperature change.

III. Use each solution in a circuit with a battery and lamp and see how bright the lamp glows.

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

**19.** Which species are a conjugate pair according to the Brønsted-Lowry theory?

A. CH3COOH and CH3CHO

B. NH3 and BF3

C. H2NO3+ and NO3–

D. H2SO4 and HSO4–

**20.** Which is **not** a strong acid?

A. Nitric acid

B. Sulfuric acid

C. Carbonic acid

D. Hydrochloric acid

**HL Questions: The following questions 21 – 31 are HL level questions**

**21.** Which is a buffer solution?

I. 0.01 mol dm–3 HCl, 0.01 mol dm–3 NaCl

II. 0.01 mol dm–3 CH3COOH, 0.01 mol dm–3 CH3COONa

A. I only

B. II only

C. Both I and II

D. Neither I nor II

(Total 1 mark)

**22.** The *K*a value for an acid is 1.0×10–2. What is the *K*b value for its conjugate base?

A. 1.0×10–2

B. 1.0×10–6

C. 1.0×10–10

D. 1.0×10–12

(Total 1 mark)

**23.** Separate 20.0 cm3 solutions of a weak acid and a strong acid of the same concentration are titrated with NaOH solution. Which will be the same for these two titrations?

I. Initial pH

II. pH at equivalence point

III. Volume of NaOH required to reach the equivalence point

A. I only

B. III only

C. I and II only

D. II and III only

(Total 1 mark)

**24.** An acid-base indicator, HIn, dissociates according to the following equation.

HIn(aq)  H+(aq) + In–(aq)

colour A colour B

Which statement about this indicator is correct?

I. In a strongly acidic solution colour B would be seen.

II. In a neutral solution the concentrations of HIn(aq) and In–(aq) must be equal.

III. It is suitable for use in titrations involving weak acids and weak bases.

A. I only

B. II only

C. III only

D. None of the above

(Total 1 mark)

**25.** Which compound, when dissolved in aqueous solution, has the highest pH?

A. NaCl

B. Na2CO3

C. NH4Cl

D. NH4NO3

(Total 1 mark)

**26.** Which neutralization reaction could use phenolphthalein (p*K*a = 9.3) and not methyl orange (p*K*a = 3.7) as an indicator?

A. NaOH(aq) and HNO3(aq)

B. NH3(aq) and CH3COOH(aq)

C. NaOH(aq) and CH3COOH(aq)

D. NH3(aq) and HNO3(aq)

(Total 1 mark)

**27.** An experiment was carried out to determine the concentration of aqueous ammonia by titrating it with a 0.150 mol dm–3 sulfuric acid solution. It was found that 25.0 cm3 of the aqueous ammonia required 20.1 cm3 of the sulfuric acid solution for neutralization.

(a) Write the equation for the reaction and calculate the concentration, in mol dm–3, of the aqueous ammonia.

(4)

(b) Several acid-base indicators are listed in Table 16 of the Data Booklet. Identify **one** indicator that could be used for this experiment. Explain your answer.

(3)

(c) (i) Determine the pOH of 0.121 mol dm–3 aqueous ammonia (p*K*b= 4.75).

(4)

(ii) State what is meant by the term *buffer solution*, and describe the composition of an acid buffer solution in general terms.

(3)

(iii) Calculate the pH of a mixture of 50.0 cm3 of 0.100 mol dm–3 aqueous ammonia and 50.0 cm3 of 0.0500 mol dm–3 hydrochloric acid solution.

(4)

(Total 18 marks)

**28.** (a) Predict and explain, using equations where appropriate, whether the following solutions are acidic, alkaline or neutral.

(i) 0.1 mol dm–3 FeCl3(aq)

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(1)

(ii) 0.1 mol dm–3 NaNO3(aq)

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(1)

(iii) 0.1 mol dm–3 Na2CO3(aq)

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(1)

(Total 3 marks)

**29.** 0.100 mol dm–3 hydrochloric acid solution is added to 25.0 cm3 0.100 mol dm–3 ammonia solution and the pH is recorded until a total of 35.0 cm3 hydrochloric acid has been added.

(i) Sketch a graph to show how the pH changes as hydrochloric acid is added to the ammonia solution. Use a pH scale of 0–14, and an acid volume scale of 0–35 cm3. Explain the shape of the curve.

(6)

(ii) Use table 17 of the Data Booklet to suggest an indicator that could be used in the titration, explaining your choice.

(2)

(Total 8 marks)

**30.** With reference to Table 16 in the Data Booklet, determine the pH of a 0.100 mol dm–3 solution of propanoic acid. (hint: which I shouldn’t give, use ICE chart)

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(Total 3 marks)